A Summary of Okanagan Sockeye Salmon (*Oncorhynchus nerka*) Escapement Survey Observations by Date and River Segment from 1947 to 2001

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ABSTRACT

Stockwell, M. M. and K. D. Hyatt. 2003. A summary of Okanagan sockeye salmon (*Oncorhynchus nerka*) escapement survey observations by date and river segment from 1947 to 2001. Can. Data. Rep. Fish. Aquat. Sci. 1106: 34 p. plus data CD-ROM.

Canadian and U.S. fisheries personnel have conducted surveys of annual sockeye salmon (*Oncorhynchus nerka*) spawner abundance in the Okanagan River for more than 50 years. This report compiles escapement survey observations (1947-2001) gathered by date and location at the Okanagan River spawning grounds in British Columbia and at the Wells Dam fishway on the Columbia River, Washington. Data are presented in summary tables within this report and as raw observations recorded on Microsoft Excel worksheets on the accompanying CD-ROM. We obtained all escapement data from pre-existing documents, internet accessible databases, and personal contact with fishery observers.

The results reported here provide background support to the Okanagan Basin Technical Working Group, and the Fish and Water Management Tools project (FWMT). The aim of the FWMT project is to provide fisheries biologists and water managers with a set of decision support tools that will enable them to better balance water management practices (e.g. flood control) with fish protection and production objectives in the Okanagan basin.

RÉSUMÉ

Stockwell, M. M. and K. D. Hyatt. 2003. A summary of Okanagan sockeye salmon (*Oncorhynchus nerka*) escapement survey observations by date and river segment from 1947 to 2001. Can. Data. Rep. Fish. Aquat. Sci. 1106: 34 p. plus data CD-ROM.

Depuis plus de 50 ans, des employés d'organismes de gestion des pêches canadiens et étatsuniens effectuent chaque année des relevés de l'abondance des géniteurs de saumon rouge (*Oncorhynchus nerka*) dans la rivière Okanagan. Ce rapport présente la compilation des données sur les échappées recueillies entre 1947 et 2001 dans les lieux de fraie de la rivière Okanagan (Colombie-Britannique) et dans la passe migratoire du barrage Wells situé sur le fleuve Columbia (État de Washington, États-Unis). Ces données sont classées en fonction de la date et du lieu où elles ont été recueillies et présentées dans des tableaux sommaires (dans ce rapport) et sous forme de données brutes dans des feuilles de calcul Microsoft Excel (enregistrées sur le CD-ROM joint au rapport). Nous avons obtenu ces données dans des bases de données disponibles sur Internet, dans divers documents et auprès d'observateurs des pêches.

Les résultats présentés dans ce rapport appuient les travaux du Okanagan Basin Technical Working Group et le projet d'outils de gestion des poissons et des eaux (FWMT). L'objectif de ce projet est de fournir un ensemble d'outils d'aide à la décision aux biologistes des pêches et aux gestionnaires des eaux afin de leur permettre de mieux adapter les pratiques de gestion des eaux (p. ex. lutte contre les inondations) aux objectifs de protection et de production des poissons dans le bassin versant de la rivière Okanagan.

INTRODUCTION

Okanagan River sockeye salmon (*Oncorhynchus nerka*) are the southerly most distributed stock of this species in Canada. They are the only significant remnant stock of more than a dozen anadromous salmon stocks that historically returned to Canada through U.S. portions of the Columbia River. Extensive hydroelectric development in both Canada and the United States, agricultural, forest, urban, and recreational land use practices, water management for flood control, restriction to poor quality habitat and regional climate change all pose serious threats to Okanagan sockeye salmon (Chapman et al. 1995, Fryer 1995). Long-term maintenance of abundance levels sufficient to avoid stock extirpation and to meet First Nations aspirations for harvest in both Canada and the United States continues to be a challenge.

Populations of Okanagan River sockeye salmon and Okanagan Lake kokanee (*O. nerka*) have both experienced declines in recent decades (Hyatt and Rankin 1999, Ashley et al. 1998). Annual production variations for both species are influenced significantly by water regulation decisions at a series of low head dams built and operated to meet flood control, fisheries and other water use objectives (Anon. 1954). Water management decisions influence fish production because of their effects on (1) seasonal water level variations at Okanagan Lake beaches where kokanee spawn, (2) discharge, water level and current velocity fields downstream in sections of the Okanagan River where sockeye salmon spawn and (3) water quality of the lake rearing-habitats of both sockeye and kokanee.

During 2001, fisheries biologists and water managers initiated a project to develop a set of decision support models to improve the basis for water management decisions that influence annual production variations of these fish. The fish and water management tools (FWMT) project (Hyatt et al. 2001) is an active collaboration among government agencies, First Nations groups and industry. The FWMT project required assembly and analysis of selected physical (Stockwell et al. 2001) and biological data to determine historic and predict future impacts of climate and water supply changes on various life history stages of Okanagan sockeye and kokanee.

Since approximately 1947, annual surveys to estimate the abundance of sockeye spawners in to the Okanagan River have been conducted by fisheries personnel associated with various government (e.g. Fisheries and Oceans Canada, Washington State Department of Fisheries, United States Department of Fish and Wildlife), non-government (Douglas County Public Utility District, private consultants) and First Nations (Okanagan Nation Fisheries Commission, Colville Confederated Tribes) groups. Furthermore, different groups have applied a variety of survey methods, effort levels and analytical techniques to obtain spawner counts, thus generating a wide range of summary estimates within and between years. Over the last 50 years, survey methods have included: (1) combined stream float and bank walks, (2) Wells Dam fishway counts, (3) helicopter over-flights, (4) hydro-acoustic or video estimates at Zosel Dam (e.g. Anglea and Johnson 1991, Hatch et al. 1992) and (5) mark-recapture programs (e.g. Craddock 1954, 1956 and 1957, Hagen and Grette 1994). Over the

same period, a variety of analytical methods have been employed to produce summary estimates of annual escapement. These include: (1) mark-recovery analyses (e.g. Anon. 1997a and 1997b, Hagen and Grette 1994), (2) area-under-the-curve analyses (e.g. Gangmark and Fulton 1952, Craddock 1958, Klinge 1996) and (3) arithmetic expansions of raw counts to estimate peak, spawner abundance values (Fisheries and Oceans Canada (CDFO) Stream Inspection Logs, Kamloops, BC).

Cross calibration studies have shown that escapement estimates differ greatly when they are derived from different survey methods, effort and/or subsequent analytical techniques (Shardlow et al. 1987, Tschaplinski and Hyatt 1991). For example, variable survey methods produced annual estimates of Okanagan sockeye ranging from 15,165 to 67,542 fish in 1953; in 1992, estimates ranged from 10,518 to 42,410 (Table 1).

We have chosen to assemble historic sockeye abundance based upon raw observations obtained from long-term, relatively consistent assessment methods. The most common survey method, across all years, involves visual enumeration of the fish during raft trips down the upper portion of the spawning grounds and during walking tours of the lower portion. Raw observations from standard float/walk surveys of the spawning grounds in British Columbia and observations collected at Wells Dam fishway in Washington State supply the longest, continuous sets of annual sockeye assessments. We assembled the results of these observations in this report to provide the FWMT project with a long-term profile of Okanagan sockeye salmon abundance variations.

METHODS

Okanagan sockeye escapement data, from 1947 to 2001, were assembled from various sources including: electronic databases (e.g. Fish Passage Center <www.fpc.org> and Columbia Basin Research <www.cbr.washington.edu>), published documents, unpublished reports and data records from a variety of agencies including government (e.g. Fisheries and Oceans Canada, Washington Dept. of Fish and Wildlife, Public Utility District No. 1 of Douglas County), First Nations (e.g. Okanagan Nation Fisheries Commission), and non-governmental organizations (e.g. Summit Environmental Consultants, Ltd.). We extracted raw counts of live and dead sockeye as observed by river segment, date, and year and stored them as individual data in a MS Excel spreadsheet. If the information was provided, we also included notations regarding survey conditions or methods that may have influenced the reliability of the original observations (Table 2, Figure 1).

WELLS DAM COUNTS

The Wells Hydroelectric project, located 830 km from the mouth of Columbia River (Figures 2 and 3), is the last of nine Columbia dam sites that Okanagan sockeye must pass enroute to their spawning grounds. All sockeye passing Wells, are bound for

the Okanagan River[1]. These fish typically arrive at Wells Dam during the last week of June or the first week in July and continue to migrate past Wells Dam until late August (Figure 4).

Each year, the U.S. Army Corps of Engineers (USACE) has monitored daily and total, seasonal numbers of adult sockeye migrating through Wells since the dam became operational in 1967. Currently, salmon passage is video monitored at fish ladders 24 hours a day from May 1 to November 15 each year. Experienced personnel then view the video tapes to identify, count and record the numbers of fish migrating upstream. Prior to 1996, personnel stationed in front of viewing windows carried out visual counts for 50 minutes per hour, 16 hours per day, throughout the migratory season. These counts were subsequently expanded to account for hourly passage rates. The remaining 8 hours were video taped for enumeration the following day (Bisson et al. 1999, FPC 2002, Hyatt and Rankin 1999).

Annual variations in monitoring procedure at Wells Dam are documented at the Northwest Power and Planning Council (NPPC), Fish and Wildlife Program, Fish Passage Center web site <http://www.fpc.org/Metadata/FPC_Adult_Metadata.asp>. Total annual counts, from 1977 to present, are maintained at the Fish Passage Center <http://www.fpc.org/adult_history/YTD-WEL.htm>; daily counts for each of these years are available at Columbia Basin Research, DART (Data Access in Real Time), Adult Passage Reports <http://www.cbr.washington.edu/dart/adult_rpt.html>. The Natural Resource Management Section, USACE provides daily, monthly and yearly summaries of salmon passage through Columbia River dams from 1998 to the current year at <https://www.nwp.usace.army.mil/op/fishdata/welcome.htm>.

SPAWNING GROUND SURVEYS

Once past Wells Dam, sockeye migrate from the Columbia mainstem to the Okanagan River and then into Osoyoos Lake where they hold until late September. Some years, migration may be delayed from 1 to 3 weeks when high, summer water temperature in the Okanagan River functions as a barrier to migration (Hyatt et al. 2003, in review, Hyatt and Rankin 1999, Major and Mighell 1966). Typically, the sockeye start to move onto the spawning grounds in late September. Spawning begins in early October, peaks around mid-October and has ended by the first week in November (Figure 5).

Spawning Ground Description

Sockeye spawn in a 21.5 km stretch of river from McIntyre Dam, located at the outlet of Vaseux Lake, to Osoyoos Lake (Figures 6 and 7). McIntyre Dam[2], a water

[1] A small number (<100) of adult sockeye are observed in the Methow River, WA each year during annual chinook assessments. These sockeye may be a remnant stock from the Methow or Okanagan River strays (Chapman et al. 1995).

[2] McIntyre Dam may also be referred to as Vaseux, Vaseaux, South Okanagan Lands Project (S.O.L.P.), or South Okanagan Lands Irrigation District (S.O.L.I.D.) Dam in published literature.

control structure built by the South Okanagan Lands Irrigation District (S.O.L.I.D.) in 1921, creates the upper-most barrier to anadromous sockeye. In years of high flow (e.g. 1997, 2000) however, a few sockeye are likely to migrate past this barrier and spawn just upstream of Vaseux Lake (H. Wright, ONFC, pers. comm.). In 1957, as part of the S.O.L.I.D. flood control project, the river was straightened and channelized from approximately 1.6 km above the town of Oliver, down to Osoyoos Lake. An 8.5 km non-engineered section remains below McIntyre Dam. This includes a 4.5 km "natural" segment immediately below the dam which provides the most suitable spawning habitat for sockeye and another 4.0 km dyked but still semi-natural segment. The channelized section contains 13 vertical drop structures (VDS) built to dissipate hydraulic energy. A deep pool forms below each VDS, providing holding areas for returning sockeye; small numbers may spawn in the areas just above each VDS (Anon. 2001). The drop structures are numbered consecutively (1 to 13) between Osoyoos Lake and McIntyre Dam and are used by fisheries observers, as permanent stream markers delimiting stream segments for spawner enumerations. A minor component of the sockeye population may spawn in Osoyoos Lake; however, 1971 to 1974 were the last years that lake observations were explicitly recorded (Allen and Meekin 1980).

The portion of river where sockeye spawn includes two main areas defined for assessment purposes (Figure 7) as the "Index" Section and the "Channel" Section. The Index Section, which supports the majority of spawners, begins at McIntyre Dam and ends downstream at VDS 13. In some years, surveyors have extended the Index Section to include VDS 12. The Channel Section begins at VDS 13 and continues to Osoyoos Lake. The channelized portion of the river supports a very small percentage (<25%) of the spawning population and therefore, in years when available time, available personnel or weather create constraints, this section is not inspected.

Current Survey Methods

Index Section: The Okanagan Nation Fisheries Commission (ONFC) conducts weekly surveys from the time of sockeye arrival on the spawning grounds to the end of the spawning period (August through October). Three observers in one zodiac, floating the river from Deer Park Estates (just below McIntyre Dam) to VDS 13, visually enumerate sockeye. Observers 1 and 2 count live and dead fish, and redds on either side of the thalweg; observer 3 records the information. For all float trips, observers are equipped with polarized glasses and tally counters. Tally counters are in single and 10 unit increments, with use depending on fish densities (K. Long, ONFC, pers. comm.). Counts are generally recorded for the section as a whole, but in some years counts may be separated by sub-sections (e.g. McIntyre Dam to Highway 97 Bridge crossing and Highway 97 to VDS 13). All float surveys include walks of major side channels. During the years 1998 to 2001, CDFO personnel and Washington Department of Fisheries (WDF) personnel also conducted 1 to 3 float-and-walk surveys per year.

In some years, fisheries observers attempted to decrease the amount of bias in annual sockeye counts by altering the basic survey method. In 1999, back-to-back surveys of the Index Section were conducted by two groups of observers (ONFC) in two

boats floating side by side. One group would count sockeye and redds on one side of the thalweg while the other group would count sockeye on the other side. On the second pass, each group would count fish on the opposite side of the river from the first pass (Anon. 2000). The final recorded counts of live and dead sockeye, and redds equaled the mean of the counts from the two passes. In the year 2000, both one and two-boat float surveys were carried out. The one-boat surveys produced more reliable results (Brent Phillips, Summit Environmental Ltd., pers. comm.) and are used as the final counts for the purposes of this report.

Channel Section: Observers conduct weekly surveys of the Channelized Section throughout the spawning period. One or more observers count sockeye on one side of the river and then the other by walking along the dyke berm that parallels the river. The observer inspects each VDS section from the drop structure itself to approximately 60m to 100m upstream. Attempts are made to view sockeye in the deep water below each drop structure; however, poor visibility caused by turbulence generally prevents systematic counting in these pools. Counts are recorded separately for each VDS section (K. Long, ONFC, pers. comm.).

Historic Survey Methods

Canadian, U.S. and/or private fisheries agencies have conducted similar versions of the standard float and walk surveys, as described above, on the Okanagan sockeye spawning grounds since the 1940's. Two to three observers in a rubber raft or boat would float the river between Vaseux Lake and the town of Oliver and count live or live plus dead sockeye on each side of the thalweg. Observers would then inspect the lower portion of the spawning area, between Oliver and Osoyoos Lake, by walking along the dyke berm that paralleled the river (e.g. Allen and Meekin 1980, Craddock 1958, Gangmark and Fulton 1952, Hansen 1993, Klinge 1996). Prior to the construction of flood control structures (1957), counting sections were designated by bridge crossings and distance markers (Figure 6).

Miscellaneous Enumeration Methods

Researchers have conducted several supplementary programs, over the years, to assess Okanagan sockeye escapements. The U.S. Fish and Wildlife Service conducted mark-recovery programs from 1954 to 1957 (Craddock 1954, 1956, 1957 and Craddock and Major 1959b). Sockeye were captured and tagged downstream at the Zosel Dam fishways and later recovered upstream during the spawning ground surveys. The tagging studies were discontinued in 1958 as they "proved highly inconsistent" (Craddock and Major 1959b). In 1991 and 1993, Biosonics, Inc. (on contract to Douglas County Public Utility District No. 1 of Wenatchee, WA) evaluated sockeye escapement by means of acoustical equipment located in Zosel Dam spillway (Anglea and Johnson 1992, Sullivan and Dawson 1994); underwater video technology at Zosel was used to assess escapement for 1992 (Hatch et al. 1992). During the 1993, 1996, and 1997 spawning seasons, multiple mark-recovery programs were conducted

(for DCPUD) in the Index Section of the river (Anonymous 1997a, 1997b and Hagen and Grette 1994).

We have identified the above short-term, miscellaneous studies for the reader's awareness but have not included most of these data with this report.

RESULTS AND DISCUSSION

Table 3 presents the annual summaries of adult Okanagan sockeye migration through the Wells Dam on the Columbia River for the years 1967 through to 2001. Since the onset of dam operations in 1967, annual sockeye passage has ranged from a high of 113,232 fish in 1967 to fewer than 5000 in the years 1994, 1995, and 1998. Data for daily and annual Wells passage are included as Excel worksheets on the accompanying CD-ROM (Table 4). Daily salmon passage is maintained and updated (1977 to present) at Columbia Basin Research, DART (Data Access in Real Time), Adult Passage Reports <http://www.cbr.washington.edu/dart/adult_rpt.html>; total annual passage is maintained and updated by the Fish Passage Center at <http://www.fpc.org/Metadata/FPC_Adult_Metadata.asp>.

Annual Okanagan River spawning ground counts are summarized by inspection date and data source for the Index Section (Table 5) and for the Channel Section (Table 6). For the purposes of this document, counts have been condensed to a single observation by date. However, details of raw observations by unique stream segment, by date may be found in the file *Sockeye_Counts.xls* on the accompanying CD-ROM (Table 4, Figure 1). Peak live estimates for the Index Section have ranged from highs of over 22,000 fish in 2000 and 2001 to less than 500 in 1994 and 1998.

Annual summary estimates from the spawning grounds are considerably less than total passage through Wells Dam (mean 31% of Wells, Hyatt and Rankin 1999). This difference may reflect the combined effects of differences in enumeration methods employed between the two locations, inconsistency of timing and effort of inspections on the spawning grounds, and losses of fish between the time of the midsummer counts at Wells and the fall counts in the Okanagan River (Hyatt and Rankin 1999). There are small native fisheries for Okanagan sockeye by the Colville Confederated Tribes, WA, U.S.A. and the Okanagan First Nations, B.C., Canada. However, the total catch has been <100 fish annually since the mid 1980s (Stockwell and Hyatt in prep.). Pre-spawn mortalities may be related to heat induced migration delays (Chapman et al. 1995, Hyatt and Rankin 1999, Hyatt et al. 2003, in review), nitrogen super-saturation below Chief Joseph Dam (Meekin and Allen 1974), and non-reported catch. To date, no studies have been implemented to accurately establish the exact causes or annual magnitude of pre-spawn mortality between Wells Dam and the Okanagan River spawning grounds (but see Alexander et al. 1998).

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Table 1. Two examples of variation in annual summary escapement estimates for Okanagan sockeye salmon derived from different survey and analytical methods.

Year	Method	Summary Estimate	Data Source
1953	peak abundance from 5 float-and-walk surveys	15,165	Anon. 1954
	counts at Zosel Dam fishway	67,542	Major and Mighell 1966
1992	peak abundance from 1 float-and-walk survey	10,518	CDFO Stream Inspection Logs
	mark-recapture analysis	21,226	Hansen 1993
	underwater video - low estimate	25,172	Hatch et al. 1992
	underwater video - high estimate	42,410	Hatch et al. 1992
	Wells Dam passage	41,951	FPC 2002

Table 2. Descriptions of the fields used in the MS Excel spreadsheet "Sockeye_Counts.xls" included on the study area CD-ROM (see also Figure 1).

FIELD	FORMAT	DESCRIPTION
Year	Number	Year in which spawner enumeration survey was carried out.
Date	Date	Specific date at which survey was carried out.
Location	Text	B.C. Waterbody Identification number (00000OKAN)
Species	Text	Species surveyed for (always as "sk" or sockeye for the purposes of this report)
Start_sort [1]	Number	Numerical code of river location at which specific survey observation began (see Table 8 for sort codes).
Start	Text	Physical river location at which survey observation began.
End_sort [1]	Number	Numerical code of river location at which specific survey observation ended (see Table 8 for sort codes).
End	Text	Physical river location at which survey observation ended.
Live	Number	Number of live fish observed.
Dead	Number	Number of dead fish observed.
Total	Number	Total number of fish observed.
Redds	Number	Number of sockeye redds observed.
Fish Comments	Text	Comments relating specifically to the actions, conditions or distribution of the observed sockeye.
Observers	Text	Individual(s) or organization(s) conducting the survey and/or recording the observations.
Method	Text	Survey method used to enumerate fish.
Water Clarity	Text	A subjective (e.g. good, poor) or physical (e.g. specific measurement in m) indication of fish visibility during survey.
Weather	Text	An indication of cloud cover, precipitation, wind or other weather characteristic that may influence fish visibility.
Countability	Text	An overall evaluation of fish visibility during survey.
Method Comments	Text	Comments regarding survey method or circumstances (e.g. weather) that would influence the outcome of the observations.
Data Source ID	Number	Identifies individual information sources that data were retrieved from (see Table 7 for codes and included as sheet DATA_SOURCE_ID# in.xls file).

[1] Over the years, surveyors have described observation boundaries by means of landmarks (e.g. dams, bridges), markers (i.e. A through N) and/or physical structures (i.e. VDS 1 through VDS 13). In order for count data to be sorted geographically within the spreadsheet, unique numbers were assigned to each of these locations. Segment boundaries are numbered consecutively, north to south, from McIntyre Dam (#1) to Osoyoos Lake (#30) (Table 8).

Table 3. Total annual adult sockeye passage at Wells Dam on the Columbia River, Washington, U.S.A. (1967 - 2001).

Year	Wells Dam Count	Year	Wells Dam Count
1965		1985	52,989
1966		1986	34,788
1967 [b]	113,232	1987	40,120
1968	81,530	1988	33,978
1969	17,352	1989	15,976
1970	50,667	1990	7,609
1971	48,172	1991	27,490
1972	33,398	1992	41,951
1973	37,178	1993	27,894
1974	16,716	1994	1,666
1975	22,286	1995	4,892
1976	27,619	1996	17,701
1977 [c]	21,973	1997	24,621
1978	7,644	1998	4,404
1979	26,655	1999	12,228
1980	26,573	2000	59,944
1981	28,234	2001	74,453
1982	19,005		
1983	27,925		
1984	81,054		

[b] Wells Dam sockeye counts from 1961 to 1976 are annual totals generated from StreamNet Data Query System URL: <http://query.streamnet.org/Request.cfm?cmd=BuildCriteria&NewQuery=BuildCriteria&Required=Species&DataCategory=4&Species=4&Dam=10545> (05-Oct-01).

[c] Data from 1977 to 2001 are totals of daily passage reports generated from the University of Washington, Columbia River DART web site at http://www.cbr.washington.edu/dart/adult_rpt.html (13-Sep-01).

Table 4. CD-ROM file directory of adult sockeye salmon enumeration observations assembled for the Okanagan River.

File Name	Description
CDRFAS_1106.pdf	Adobe®Acrobat® 5.0 version of Canadian Data Report of Fisheries and Aquatic Sciences 1106
Sockeye_Counts.xls	Microsoft® Office XP Professional, Excel© file
(sheet) DATA	Details of Okanagan sockeye counts by date and by location
(sheet) SORT_CODES	Identifies number codes required to sort individual counts per section by geographical order
(sheet) DATA_SOURCE_ID#	Identifies individual information sources that data were retrieved from
Wells_Sockeye.xls	
(sheet) WELLS_ANNUAL	Annual sockeye passage at Wells Dam for the years 1967 to 2001
(sheet) WELLS_DAILY	Daily sockeye passage at Wells Dam for the years 1977 to 2001

Table 5. Summary of raw counts by date of adult sockeye returns to the Index Section of the Okanagan River compiled from standard stream float-and-walk surveys (1947 - 2001).

Date	Adult Sockeye Counted			Index Section Boundaries [d]	# of Sub-sections Counted [e]	*Data Set ID#* [f]
	Live	Dead	Total			
02-Oct-47	1,191		1,191	McIntyre Dam - 2nd Bridge	2	*4*
09-Oct-47	2,257		2,257	McIntyre Dam - 2nd Bridge	2	*4*
16-Oct-47	1,425		1,425	McIntyre Dam - 2nd Bridge	2	*4*
24-Oct-47	0		0	McIntyre Dam - 2nd Bridge	2	*4*
23-Sep-48	10		10	McIntyre Dam - 1st Bridge	1	*1*
30-Sep-48	1,084		1,084	McIntyre Dam - 1st Bridge	1	*1*
12-Oct-48	1,430		1,430	McIntyre Dam - Marker H	2	*1*
29-Sep-49	82		82	McIntyre Dam - 2nd Bridge	2	*2*
05-Oct-49	83		83	McIntyre Dam - 1st Bridge	1	*2*
20-Oct-49	0		0	McIntyre Dam - 1st Bridge	1	*2*
26-Sep-51	506		506	McIntyre Dam - 2nd Bridge	2	*4*
04-Oct-51	4,548		4,548	McIntyre Dam - 2nd Bridge	2	*4*
10-Oct-51	2,860		2,860	McIntyre Dam - 2nd Bridge	2	*4*
17-Oct-51	1,315		1,315	McIntyre Dam - 2nd Bridge	2	*4*
22-Sep-52	2,094		2,094	McIntyre Dam - 2nd Bridge	2	*3*
29-Sep-52	5,333	253	5,586	McIntyre Dam - 2nd Bridge	2	*3*
06-Oct-52	8,534	715	9,249	McIntyre Dam - 2nd Bridge	2	*3*
12-Oct-52	5,455	1,087	6,542	McIntyre Dam - 2nd Bridge	2	*3*
20-Oct-52			1,906	McIntyre Dam - 2nd Bridge	2	*3*
22-Sep-53	198		198	McIntyre Dam - 2nd Bridge	2	*5*
29-Sep-53	3,801		3,801	McIntyre Dam - 2nd Bridge	2	*5*
06-Oct-53	12,246		12,246	McIntyre Dam - 2nd Bridge	2	*5*
13-Oct-53	12,829		12,829	McIntyre Dam - 2nd Bridge	2	*5*
20-Oct-53	834		834	McIntyre Dam - 2nd Bridge	2	*5*
21-Sep-54	650	2	652	McIntyre Dam - 2nd Bridge	2	*6*
28-Sep-54	3,722	63	3,785	McIntyre Dam - 2nd Bridge	2	*6*
05-Oct-54	5,138	415	5,553	McIntyre Dam - 2nd Bridge	2	*6*
12-Oct-54	2,940	516	3,456	McIntyre Dam - 2nd Bridge	2	*6*
19-Oct-54	514	1,577	2,091	McIntyre Dam - 2nd Bridge	2	*6*
27-Sep-55	6,935	3	6,938	McIntyre Dam - Marker I	5	*7*
04-Oct-55	15,388	1,286	16,674	McIntyre Dam - Marker I	5	*7*
11-Oct-55	6,522	938	7,460	McIntyre Dam - Marker I	5	*7*
18-Oct-55	9,498	3,036	12,534	McIntyre Dam - Marker I	5	*7*
25-Oct-55	363	1,101	1,464	McIntyre Dam - Marker I	5	*7*

[d] Refer to Figures 6 and 7 for location details.

[e] Refers to the number of unique sub-sections counted per date. Individual observations are included as file "Sockeye_Counts.xls" on the accompanying CD-ROM (Table 4).

[f] Refers to the source of original data(Table 7).

Table 5 (cont'd)

Date	Adult Sockeye Counted			Index Section Boundaries [d]	# of Sub-sections Counted [e]	*Data Set ID#*[f]
	Live	Dead	Total			
25-Sep-56	1,271	2	1,273	McIntyre Dam - Marker M	8	*8*
02-Oct-56	8,977	4	8,981	McIntyre Dam - Marker M	8	*8*
09-Oct-56	15,527	56	15,583	McIntyre Dam - Marker M	8	*8*
16-Oct-56	9,959	1,454	11,413	McIntyre Dam - Marker M	8	*8*
23-Oct-56	910	1,394	2,304	McIntyre Dam - Marker M	8	*8*
25-Sep-57	985		985	McIntyre Dam - Marker K	6	*9*
01-Oct-57	3,207	4	3,211	McIntyre Dam - VDS 13	7	*9*
08-Oct-57	8,499	34	8,533	McIntyre Dam - VDS 13	7	*9*
15-Oct-57	6,719	680	7,399	McIntyre Dam - VDS 13	7	*9*
22-Oct-57	1,858	1,848	3,706	McIntyre Dam - Marker K	6	*9*
30-Sep-58	3,188	0	3,188	McIntyre Dam - VDS 13	7	*10*
07-Oct-58	10,612	16	10,628	McIntyre Dam - VDS 13	7	*10*
14-Oct-58	8,653	441	9,094	McIntyre Dam - VDS 13	7	*10*
21-Oct-58	1,474	403	1,877	McIntyre Dam - VDS 13	7	*10*
29-Sep-59	8,599	73	8,672	McIntyre Dam - VDS 13	6	*11*
06-Oct-59	19,073	1,132	20,205	McIntyre Dam - VDS 13	6	*11*
13-Oct-59	3,662	1,208	4,870	McIntyre Dam - VDS 13	6	*11*
20-Oct-59	1,154	275	1,429	McIntyre Dam - VDS 13	6	*11*
29-Sep-60	993	5	998	McIntyre Dam - VDS 13	6	*12*
04-Oct-60	2,053	63	2,116	McIntyre Dam - VDS 13	6	*12*
06-Oct-60	3,271	150	3,421	McIntyre Dam - VDS 13	6	*12*
11-Oct-60	2,033	315	2,348	McIntyre Dam - VDS 13	6	*12*
18-Oct-60	552	68	620	McIntyre Dam - VDS 13	6	*12*
28-Sep-61	115	1	116	McIntyre Dam - Marker F	6	*13*
03-Oct-61	565	2	567	McIntyre Dam - Marker F	6	*13*
10-Oct-61	680	11	691	McIntyre Dam - Marker F	6	*13*
17-Oct-61	598	47	645	McIntyre Dam - Marker F	6	*13*
03-Oct-62	1,950	19	1,969	McIntyre Dam - Marker F	1	*14*
09-Oct-62	1,494	74	1,568	McIntyre Dam - Marker F	1	*14*
16-Oct-62	1,233	105	1,338	McIntyre Dam - Marker F	1	*14*
23-Oct-62	450	164	614	McIntyre Dam - Marker F	1	*14*
18-Oct-66[g]	33,380	11,485	44,865	McIntyre Dam - VDS 1	1	*15*
15-Oct-67	15,850	1,350	17,200	McIntyre Dam - VDS 13	2	*15*
11-Oct-67	15,066	766	15,832	McIntyre Dam - VDS 13	1	*16*
06-Oct-68	4,190		4,190	McIntyre Dam - VDS 12	2	*15*

[g] For 18-Oct-66, the sockeye count was recorded as one observation (Index and Channel combined).

Table 5 (cont'd)

Date	Adult Sockeye Counted			Index Section Boundaries [d]	# of Sub-sections Counted [e]	*Data Set ID#*[f]
	Live	Dead	Total			
05-Oct-71	21,731	36	21,767	McIntyre Dam - VDS 12	3	*17, 18*
12-Oct-71	13,750	3,363	17,113	McIntyre Dam - VDS 13	2	*18*
19-Oct-71	9,538	6,777	16,315	McIntyre Dam - VDS 13	2	*18*
26-Oct-71			3,228	McIntyre Dam - VDS 13	2	*18*
26-Sep-72	12	0	12	McIntyre Dam - Bridge 97	1	*18*
03-Oct-72	3,285		3,285	McIntyre Dam - VDS 13	2	*18*
10-Oct-72	9,212	8	9,220	McIntyre Dam - VDS 13	2	*18*
18-Oct-72	9,152	289	9,441	McIntyre Dam - VDS 13	2	*18*
25-Oct-72	2,489	952	3,441	McIntyre Dam - VDS 13	2	*18*
31-Oct-72			361	McIntyre Dam - VDS 13	2	*18*
01-Oct-73	2,770	80	2,850	McIntyre Dam - VDS 13	2	*18*
09-Oct-73	6,039	289	6,328	McIntyre Dam - VDS 13	2	*18*
17-Oct-73	2,900	759	3,659	McIntyre Dam - VDS 13	2	*18*
24-Oct-73	1,569	650	2,219	McIntyre Dam - VDS 13	2	*18*
19-Oct-73			3,630	McIntyre Dam - VDS 13	1	*15*
03-Oct-74	246	1	247	McIntyre Dam - VDS 13	2	*18*
11-Oct-74	2,496	1	2,497	McIntyre Dam - VDS 13	2	*18*
16-Oct-74	3,057	23	3,072	McIntyre Dam - VDS 13	2	*18*
10-Oct-74			1,180	McIntyre Dam - VDS 13	1	*15*
15-Oct-75	6,684		6,684	McIntyre Dam - VDS 13	1	*19*
22-Oct-75	3,189		3,189	McIntyre Dam - VDS 13	1	*19*
21-Oct-76			8,552	McIntyre Dam - VDS 13	1	*20*
14-Oct-77	2,967	27	2,994	McIntyre Dam - VDS 12	3	*15*
19-Oct-78	329	92	421	McIntyre Dam - VDS 12	2	*15*
24-Oct-79	694	150	844	McIntyre Dam - VDS 13	1	*15*
19-Oct-83	3,400	30	3,430	McIntyre Dam - VDS 12	3	*15*
16-Sep-84			200	McIntyre Dam - VDS 13	1	*15*
01-Oct-84			2,200	McIntyre Dam - VDS 13	2	*15*
16-Oct-84	33,091	930	34,021	McIntyre Dam - VDS 13	3	*15*
17-Oct-85	19,060	492	19,552	McIntyre Dam - VDS 13	3	*15*
24-Oct-85	8,200	8,256	16,456	McIntyre Dam - VDS 12	2	*21*
17-Oct-86	8,290	80	8,370	McIntyre Dam - VDS 13	2	*22*
22-Oct-86	6,377	2,679	9,056	McIntyre Dam - VDS 12	3	*23*
20-Oct-87	12,065	125	12,190	McIntyre Dam - VDS 12	3	*22*
18-Oct-88			18,961	McIntyre Dam - VDS 12	4	*22*

Table 5 (cont'd)

Date	Adult Sockeye Counted			Index Section Boundaries [d]	# of Sub-sections Counted [e]	*Data Set ID#*[f]
	Live	Dead	Total			
17-Oct-89	9,990	210	10,200	McIntyre Dam - VDS 13	2	*22*
17-Oct-90	1,456		1,456	McIntyre Dam - VDS 13	2	*22*
24-Oct-91	6,235	930	7,165	McIntyre Dam - VDS 13	3	*22*
19-Oct-92	8,993	1,525	10,518	McIntyre Dam - VDS 10	2	*22*
21-Sep-92	2,351	2	2,353	McIntyre Dam - VDS 13	1	*24*
28-Sep-92	26,626	4	26,630	McIntyre Dam - VDS 13	1	*24*
05-Oct-92	11,136	5	11,141	McIntyre Dam - VDS 13	1	*24*
12-Oct-92	19,705	478	20,183	McIntyre Dam - VDS 13	1	*24*
19-Oct-92	11,346	5,185	16,531	McIntyre Dam - VDS 13	1	*24*
26-Oct-92	2,500	5,451	7,951	McIntyre Dam - VDS 13	1	*24*
02-Nov-92	120	1,987	2,107	McIntyre Dam - VDS 13	1	*24*
09-Nov-92	5	1,077	1,082	McIntyre Dam - VDS 13	1	*24*
24-Oct-94	68	5	73	McIntyre Dam - VDS 12	1	*22*
20-Oct-95			1,336	VDS 13 - VDS 12	2	*22*
27-Sep-95	8	0	8	McIntyre Dam - VDS 13	2	*25*
04-Oct-95	153	0	153	McIntyre Dam - VDS 13	2	*25*
11-Oct-95	778	1	779	McIntyre Dam - VDS 13	2	*25*
18-Oct-95	1,935	25	1,960	McIntyre Dam - VDS 13	2	*25*
24-Oct-95	1,249	115	1,364	McIntyre Dam - VDS 13	2	*25*
01-Nov-95	199	221	420	McIntyre Dam - VDS 13	2	*25*
09-Nov-95	34	284	318	McIntyre Dam - VDS 13	2	*25*
15-Nov-95	2	85	87	McIntyre Dam - VDS 13	2	*25*
18-Oct-96	9,452	120	9,572	McIntyre Dam - VDS 13	2	*22*
22-Oct-97	6,536	639	7,175	McIntyre Dam - VDS 12	4	*22*
27-Oct-98	467	100	567	McIntyre Dam - VDS 12	3	*22*
05-Oct-99	1,021	4	1,025	McIntyre Dam - VDS 12	1	*26*
12-Oct-99	2,855	19	2,874	McIntyre Dam - VDS 12	1	*26*
19-Oct-99	2,273	101	2,374	McIntyre Dam - VDS 12	1	*26*
26-Oct-99	697	401	1,098	McIntyre Dam - VDS 12	1	*26*
01-Nov-99	101	263	364	McIntyre Dam - Bridge 97	1	*26*
08-Nov-99	13	255	268	McIntyre Dam - VDS 12	1	*26*
10-Oct-99	2,824	25	2,849	McIntyre Dam - VDS 13	1	*28*
18-Oct-99	1,851	319	2,170	McIntyre Dam - VDS 13	1	*28*
19-Oct-00	12,570	6,517	19,087	McIntyre Dam - VDS 12	4	*22*
13-Oct-00	25,650	445	26,095	McIntyre Dam - VDS 13	2	*28*
20-Oct-00	9,060	3,401	12,461	McIntyre Dam - VDS 13	2	*28*

Table 5 (cont'd)

Date	Adult Sockeye Counted			Index Section Boundaries [d]	# of Sub-sections Counted [e]	*Data Set ID#*[f]
	Live	Dead	Total			
22-Aug-00	7	0	7	McIntyre Dam - VDS 12	1	*26*
30-Aug-00	37	0	37	McIntyre Dam - VDS 12	1	*26*
05-Sep-00	20	0	20	McIntyre Dam - VDS 12	1	*26*
13-Sep-00	101	0	101	McIntyre Dam - VDS 12	1	*26*
20-Sep-00	49	0	49	McIntyre Dam - VDS 12	1	*26*
27-Sep-00	771	0	771	McIntyre Dam - VDS 12	1	*26*
04-Oct-00	6,551	2	6,553	McIntyre Dam - VDS 12	1	*26*
07-Oct-00	11,279	52	11,331	McIntyre Dam - VDS 12	1	*26*
11-Oct-00	13,822	88	13,910	McIntyre Dam - VDS 12	1	*26*
16-Oct-00	12,859	1,670	14,529	McIntyre Dam - VDS 12	1	*26*
21-Oct-00	3,464	3,253	6,717	McIntyre Dam - VDS 12	1	*26*
25-Oct-00	1,404	2,336	3,740	McIntyre Dam - VDS 12	1	*26*
30-Oct-00	196	921	1,117	McIntyre Dam - VDS 12	1	*26*
21-Aug-01	0	0	0	McIntyre Dam - VDS12	1	*27*
29-Aug-01	0	0	0	McIntyre Dam - VDS12	1	*27*
05-Sep-01	5	0	5	McIntyre Dam - VDS12	1	*27*
11-Sep-01	42	0	42	McIntyre Dam - VDS12	1	*27*
18-Sep-01	212	0	212	McIntyre Dam - VDS12	1	*27*
25-Sep-01	699	0	699	McIntyre Dam - VDS12	1	*27*
01-Oct-01	3,426	0	3,426	McIntyre Dam - VDS12	1	*27*
05-Oct-01	7,777	0	7,777	McIntyre Dam - VDS12	1	*27*
10-Oct-01	17,400		17,400	McIntyre Dam - VDS12	1	*27*
15-Oct-01	21,218	75	21,293	McIntyre Dam - VDS12	1	*27*
20-Oct-01	22,111	1,322	23,433	McIntyre Dam - VDS12	1	*27*
25-Oct-01	11,592	6,607	18,199	McIntyre Dam - VDS12	1	*27*
30-Oct-01	1,635	6,643	8,278	McIntyre Dam - VDS12	1	*27*
12-Oct-01	34,369	65	34,434	McIntyre Dam - VDS12	2	*28*
19-Oct-01	37,442	780	38,222	McIntyre Dam - VDS12	2	*28*
26-Oct-01	9,098	5,191	14,289	McIntyre Dam - VDS12	2	*28*

Table 6. Summary of raw counts by date of adult sockeye returns to the Channel Section of the Okanagan River compiled from standard bank-walk surveys (1947 - 2001).

Date	Adult Sockeye Counted			Channel Section Boundaries [d]	# of Sub-sections Counted [e]	*Data Set ID#* [f]
	Live	Dead	Total			
02-Oct-47	567		567	2nd Bridge - 5th Bridge	2	*4*
09-Oct-47	2,546		2,546	2nd Bridge - 5th Bridge	2	*4*
16-Oct-47	3,770		3,770	2nd Bridge - Osoyoos L	3	*4*
24-Oct-47	979		979	2nd Bridge - 5th Bridge	2	*4*
1948				Channel not counted	0	*1*
05-Oct-49	22		22	2nd Bridge - 5th Bridge	1	*2*
20-Oct-49	0	6	6	2nd Bridge - 5th Bridge	1	*2*
26-Sep-51	7		7	2nd Bridge - Osoyoos L	2	*4*
04-Oct-51	123		123	2nd Bridge - Osoyoos L	2	*4*
10-Oct-51	357		357	2nd Bridge - Osoyoos L	2	*4*
17-Oct-51	64		64	2nd Bridge - Osoyoos L	2	*4*
22-Sep-52	19		19	2nd Bridge - 4th Bridge	1	*3*
29-Sep-52	107	7	114	2nd Bridge - 4th Bridge	1	*3*
06-Oct-52	147	12	159	2nd Bridge - 4th Bridge	1	*3*
12-Oct-52	801	310	1,111	2nd Bridge - 4th Bridge	1	*3*
20-Oct-52	288		288	2nd Bridge - 4th Bridge	1	*3*
22-Sep-53	0		0	2nd Bridge - 4th Bridge	1	*5*
29-Sep-53	149		149	2nd Bridge - 4th Bridge	1	*5*
06-Oct-53	1,869		1,869	2nd Bridge - 4th Bridge	1	*5*
13-Oct-53	2,334		2,334	2nd Bridge - 4th Bridge	1	*5*
20-Oct-53	151		151	2nd Bridge - 4th Bridge	1	*5*
21-Sep-54	13	0	13	2nd Bridge - 4th Bridge	1	*6*
28-Sep-54	6	4	10	2nd Bridge - 4th Bridge	1	*6*
05-Oct-54	119	1	120	2nd Bridge - 4th Bridge	1	*6*
12-Oct-54	104	33	137	2nd Bridge - 4th Bridge	1	*6*
19-Oct-54	0	0	0	2nd Bridge - 4th Bridge	1	*6*
1955				Channel not counted	0	*7*
25-Sep-56	25	0	25	Marker M - Oscyoos L	1	*8*
02-Oct-56	42	0	42	Marker M - Osoyoos L	1	*8*
09-Oct-56	484	0	484	Marker M - Osoyoos L	1	*8*
16-Oct-56	1,798	46	1,844	Marker M - Osoyoos L	1	*8*
23-Oct-56	263	579	842	Marker M - Osoyoos L	1	*8*
1957-1965				Channel not counted	0	*9 - 14*

[d] Refer to Figures 6 and 7 for location details.

[e] Refers to the number of unique sub-sections counted per date. Individual observations are included as file "Sockeye_Counts.xls" on the accompanying CD-ROM (Table 4).

[f] Refers to the source of original data(Table 7).

Table 6 (cont'd)

Date	Adult Sockeye Counted			Channel Section Boundaries [d]	# of Sub-sections Counted [e]	*Data Set ID#*[f]
	Live	Dead	Total			
18-Oct-66 [g]	33,380	11,485	44,865	McIntyre Dam - VDS 1	1	*15*
1967-1968				Channel not counted	0	*15, 16*
05-Oct-71	963		963	VDS 13 - Osoyoos Lake	13	*17, 18*
12-Oct-71	3,761		3,761	VDS 13 - VDS 1	1	*18*
19-Oct-71	2,534		2,534	VDS 13 - VDS 1	1	*18*
26-Oct-71	1,514		1,514	VDS 13 - VDS 1	1	*18*
03-Oct-72	1,400	0	1,400	VDS 13 - VDS 1	1	*18*
10-Oct-72	2,000	2	2,002	VDS 13 - VDS 1	1	*18*
18-Oct-72	3,625	17	3,642	VDS 13 - VDS 1	1	*18*
25-Oct-72	661	43	704	VDS 13 - VDS 1	1	*18*
01-Oct-73	670	7	677	VDS 13 - VDS 1	1	*18*
09-Oct-73	2,454	31	2,485	VDS 13 - VDS 1	1	*18*
17-Oct-73			1,449	VDS 13 - VDS 1	1	*18*
19-Oct-73	1,801	214	2,015	VDS 13 - VDS 1	11	*15*
03-Oct-74	395	4	399	VDS 13 - VDS 1	1	*18*
11-Oct-74	1,274	27	1,301	VDS 13 - VDS 1	1	*18*
16-Oct-74	2,626	4	2,630	VDS 13 - VDS 1	1	*18*
10-Oct-74			500	VDS 13 - VDS 1	1	*18*
15-Oct-75	1,032		1,032	VDS 13 - VDS 1	1	*19*
22-Oct-75	275		275	VDS 13 - VDS 1	1	*19*
1976				Channel not counted	0	*20*
14-Oct-77	857	4	861	VDS 12 - VDS 1	11	*15*
19-Oct-78	118	10	128	VDS 12 - VDS 1	11	*15*
1979, 1983				Channel not counted	0	*15*
16-Sep-84	89		89	VDS 10 - VDS 1	7	*15*
01-Oct-84	1,210		1,210	VDS 12 - VDS 1	12	*15*
16-Oct-84	810	1	811	VDS 12 - VDS 1	12	*15*
17-Oct-85	790		790	VDS 12 - VDS 1	12	*15*
17-Oct-86	1,150		1,150	VDS 13 - VDS 1	14	*15*
1987				Channel not counted	0	*22*

[g] For 18-Oct-66, sockeye count was recorded as one unit (Index and Channel combined).

Table 6 (cont'd)

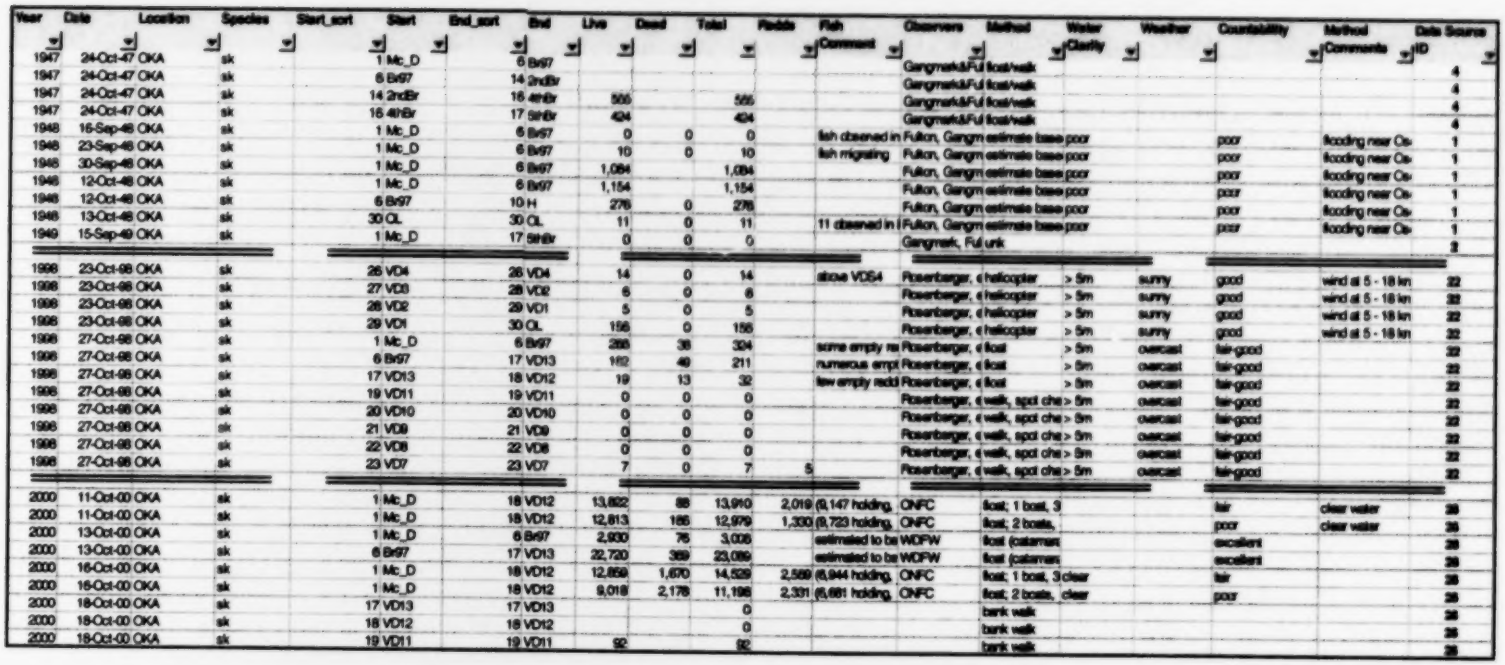
Date	Adult Sockeye Counted Live	Dead	Total	Channel Section Boundaries [d]	# of Sub-sections Counted [e]	*Data Set ID#* [f]
18-Oct-88			1,010	VDS 12 - VDS 1	11	*22*
17-Oct-89	209	10	219	VDS 13 - VDS 1	12	*22*
17-Oct-90	42		42	VDS 13 - VDS 1	12	*22*
24-Oct-91	375		375	VDS 12 - VDS 1	13	*22*
21-Sep-92	545	3	548	VDS 13 - VDS 4	2	*24*
28-Sep-92	3,610	7	3,617	VDS 13 - VDS 4	2	*24*
05-Oct-92	2,123	10	2,133	VDS 13 - VDS 4	2	*24*
12-Oct-92	978	65	1,043	VDS 13 - VDS 4	2	*24*
19-Oct-92	112	439	551	VDS 13 - VDS 10	2	*24*
26-Oct-92	120	1,155	1,270	VDS 13 - VDS 11	1	*24*
02-Nov-92	62	1,992	2,054	VDS 13 - VDS 4	2	*24*
09-Nov-92	10	599	609	VDS 13 - VDS 4	2	*24*
24-Oct-94	25		25	VDS 12 - VDS 1	1	*22*
20-Oct-95	200		200	VDS 12 - VDS 1	1	*22*
1996				Channel not counted	0	*22*
22-Oct-97	331	4	335	VDS 12 - VDS 1	13	*22*
27-Oct-98	28	1	29	VDS 12 - VDS 1	12	*22*
05-Oct-99	352	0	352	VDS 12 - VDS 1	11	*26*
12-Oct-99	355	5	360	VDS 12 - VDS 1	11	*26*
19-Oct-99	543	21	564	VDS 12 - VDS 1	11	*26*
26-Oct-99	256	17	273	VDS 12 - VDS 1	11	*26*
01-Nov-99	102	36	138	VDS 12 - VDS 1	11	*26*
08-Nov-99	8	23	31	VDS 12 - VDS 1	11	*26*
22-Aug-00	0	0	0	VDS 12 - VDS 1	11	*26*
30-Aug-00	0	0	0	VDS 12 - VDS 1	11	*26*
05-Sep-00	0	0	0	VDS 12 - VDS 1	11	*26*
13-Sep-00	62	0	62	VDS 12 - VDS 1	11	*26*
20-Sep-00	0	0	0	VDS 12 - VDS 1	11	*26*
27-Sep-00	88	0	88	VDS 12 - VDS 1	11	*26*
03-Oct-00	557		557	VDS 11 - VDS 1	11	*26*
10-Oct-00	343		343	VDS 11 - VDS 1	11	*26*
18-Oct-00	634		634	VDS 11 - VDS 1	11	*26*
20-Oct-00	361		361	VDS 11 - VDS 1	11	*26*
31-Oct-00	123		123	VDS 11 - VDS 1	11	*26*
2001				Channel not counted	0	*27*

Table 7. A summary of data sources for adult sockeye returns estimated from surveys on the Okanagan River spawning grounds.

Data Set ID #	Escapement Summary Year(s)	Data Source
1	1948	Gangmark and Fulton, 1948
2	1949	Gangmark and Fulton, 1949
3	1952	Fulton, 1952
4	1947 & 1951	Gangmark and Fulton, 1952
5	1953	Anonymous, 1954
6	1954	Craddock, 1954
7	1955	Craddock, 1956
8	1956	Craddock, 1957
9	1957	Craddock, 1958
10	1958	Craddock and Major, 1959 (b)
11	1959	Craddock and Major, 1959 (a)
12	1960	Craddock and Major, 1961
13	1961	Craddock and Parks, 1962
14	1962	Tufts and Craddock, 1963
15	1966-1968, 1973-1975 1977-1979, 1983-1985	Unpublished notes to file, Fisheries and Oceans Canada, Kamloops, B.C., Canada. (250) 851-4950
16	1967	Stockley et. al., 1969
17	1971	Cox and Brownlee, 1971
18	1971-1974	Allen and Meekin, 1980
19	1975	Moos, 1975
20	1976	Moos, 1977
21	1985	Fiscus, 1985
22	1986-1992 & 1994-1998	Stream Inspection Logs, on file at Fisheries and Oceans Canada, Kamloops, B.C., Canada. (250) 851-4950
23	1986	Fiscus, 1986
24	1992	Hansen, 1993
25	1995	Klinge, 1996
26	1999 & 2000	Summit Environmental Consultants, Ltd. Vernon, B. C., Canada. (250) 545-3672
27	2001	Okanagan Nation Fisheries Commission (ONFC), Westbank, B.C., Canada. (250) 707-0095
28	2000 & 2001	Washington Department of Fish and Wildlife, Omak, WA, U.S.A. (509) 826-7341

Table 8. Numerical codes assigned to specific locations so that sockeye counts included on the CD-ROM data files may be sorted in geographical order. Locations are numbered consecutively, north to south, from McIntyre Dam (#1) to Osoyoos Lake (#30). Refer also, to location maps (Figures 6 and 7).

Sorting Code	Locations Pre-1955	Locations Post-1955
1	Marker A or McIntyre Dam	McIntyre Dam
2	Marker B	
3	C. P. railway bridge crossing	C. P. railway bridge crossing
4	Marker C	
5	Marker D	
6	Highway 97 bridge crossing	Highway 97 bridge crossing
7	Marker E	
8	Marker F	
9	Marker G	
10	Marker H	
11	Marker I	
12	Marker J	
13	Marker K	
14	Marker L	
15	Marker M (2nd and 3rd bridge crossings)	
16	Marker N	
17		Vertical Drop Structure 13
18		Vertical Drop Structure 12
19		Vertical Drop Structure 11
20		Vertical Drop Structure 10
21	4th bridge crossing	Vertical Drop Structure 9
22		Vertical Drop Structure 8
23		Vertical Drop Structure 7
24	5th bridge crossing	Vertical Drop Structure 6
25		Vertical Drop Structure 5
26		Vertical Drop Structure 4
27		Vertical Drop Structure 3
28		Vertical Drop Structure 2
29		Vertical Drop Structure 1
30		Osoyoos Lake



Year	Date	Location	Species	Start_sort	Start	End_sort	End	Live	Dead	Total	Redds	Fish Comment	Observers	Method	Water Clarity	Weather	Countability	Method Comments	Data Source ID
1947	24-Oct-47	OKA	sk	1	Mc_D	6	Br97						Gangmark&Ful	float/walk					4
1947	24-Oct-47	OKA	sk	6	Br97	14	2ndBr						Gangmark&Ful	float/walk					4
1947	24-Oct-47	OKA	sk	14	2ndBr	16	4thBr	555		555			Gangmark&Ful	float/walk					4
1947	24-Oct-47	OKA	sk	16	4thBr	17	5thBr	424		424			Gangmark&Ful	float/walk					4
1948	16-Sep-48	OKA	sk	1	Mc_D	6	Br97	0	0	0		fish observed in	Fulton, Gangm	estimate base	poor		poor	flooding near Os	1
1948	23-Sep-48	OKA	sk	1	Mc_D	6	Br97	10	0	10		fish migrating	Fulton, Gangm	estimate base	poor		poor	flooding near Os	1
1948	30-Sep-48	OKA	sk	1	Mc_D	6	Br97	1,084		1,084			Fulton, Gangm	estimate base	poor		poor	flooding near Os	1
1948	12-Oct-48	OKA	sk	1	Mc_D	6	Br97	1,154		1,154			Fulton, Gangm	estimate base	poor		poor	flooding near Os	1
1948	12-Oct-48	OKA	sk	6	Br97	10	H	276	0	276			Fulton, Gangm	estimate base	poor		poor	flooding near Os	1
1948	13-Oct-48	OKA	sk	30	OL	30	OL	11	0	11		11 observed in l	Fulton, Gangm	estimate base	poor		poor	flooding near Os	1
1949	15-Sep-49	OKA	sk	1	Mc_D	17	5thBr	0	0	0			Gangmark, Ful	unk					2
1998	23-Oct-98	OKA	sk	26	VD4	26	VD4	14	0	14		above VD54	Rosenberger, (	helicopter	> 5m	sunny	good	wind at 5 - 18 kn	22
1998	23-Oct-98	OKA	sk	27	VD3	28	VD2	6	0	6			Rosenberger, (	helicopter	> 5m	sunny	good	wind at 5 - 18 kn	22
1998	23-Oct-98	OKA	sk	28	VD2	29	VD1	5	0	5			Rosenberger, (	helicopter	> 5m	sunny	good	wind at 5 - 18 kn	22
1998	23-Oct-98	OKA	sk	29	VD1	30	OL	156	0	156			Rosenberger, (	helicopter	> 5m	sunny	good	wind at 5 - 18 kn	22
1998	27-Oct-98	OKA	sk	1	Mc_D	6	Br97	286	38	324		some empty re	Rosenberger, (	float	> 5m	overcast	fair-good		22
1998	27-Oct-98	OKA	sk	6	Br97	17	VD13	162	49	211		numerous empt	Rosenberger, (	float	> 5m	overcast	fair-good		22
1998	27-Oct-98	OKA	sk	17	VD13	18	VD12	19	13	32		few empty redd	Rosenberger, (	float	> 5m	overcast	fair-good		22
1998	27-Oct-98	OKA	sk	19	VD11	19	VD11	0	0	0			Rosenberger, (	walk, spot cha	> 5m	overcast	fair-good		22
1998	27-Oct-98	OKA	sk	20	VD10	20	VD10	0	0	0			Rosenberger, (	walk, spot cha	> 5m	overcast	fair-good		22
1998	27-Oct-98	OKA	sk	21	VD9	21	VD9	0	0	0			Rosenberger, (	walk, spot cha	> 5m	overcast	fair-good		22
1998	27-Oct-98	OKA	sk	22	VD8	22	VD8	0	0	0			Rosenberger, (	walk, spot cha	> 5m	overcast	fair-good		22
1998	27-Oct-98	OKA	sk	23	VD7	23	VD7	7	0	7	5		Rosenberger, (	walk, spot cha	> 5m	overcast	fair-good		22
2000	11-Oct-00	OKA	sk	1	Mc_D	18	VD12	13,822	88	13,910	2,019	(9,147 holding,	CNFC	float; 1 boat, 3			fair	clear water	26
2000	11-Oct-00	OKA	sk	1	Mc_D	18	VD12	12,613	166	12,979	1,330	(8,723 holding,	CNFC	float; 2 boats,			poor	clear water	26
2000	13-Oct-00	OKA	sk	1	Mc_D	6	Br97	2,930	76	3,006		estimated to be	WDFW	float (catamar			excellent		26
2000	13-Oct-00	OKA	sk	6	Br97	17	VD13	22,720	369	23,089		estimated to be	WDFW	float (catamar			excellent		26
2000	16-Oct-00	OKA	sk	1	Mc_D	18	VD12	12,859	1,670	14,529	2,589	(8,944 holding,	CNFC	float; 1 boat, 3	clear		fair		26
2000	16-Oct-00	OKA	sk	1	Mc_D	18	VD12	9,018	2,178	11,196	2,331	(6,681 holding,	CNFC	float; 2 boats,	clear		poor		26
2000	18-Oct-00	OKA	sk	17	VD13	17	VD13			0				bank walk					26
2000	18-Oct-00	OKA	sk	18	VD12	18	VD12			0				bank walk					26
2000	18-Oct-00	OKA	sk	19	VD11	19	VD11	92		92				bank walk					26

Figure 1. Format of the Excel spreadsheet file "Sockeye_Counts.xls", which contains details of sockeye escapement survey observations by date and river segment, included on the study area CD-ROM. Local "landmarks" used to define sections for enumeration include: McIntyre Dam (Mc_D), Highway 97 Bridge (Br97), bridges at Oliver (2ndBr, 3rdBr), secondary bridges south of Oliver (4thBr, 5thBr), vertical drop structures 1-13 (VD1 - VD13). See text, Table 8, and Figures 2, 6, and 7 for details and locations.

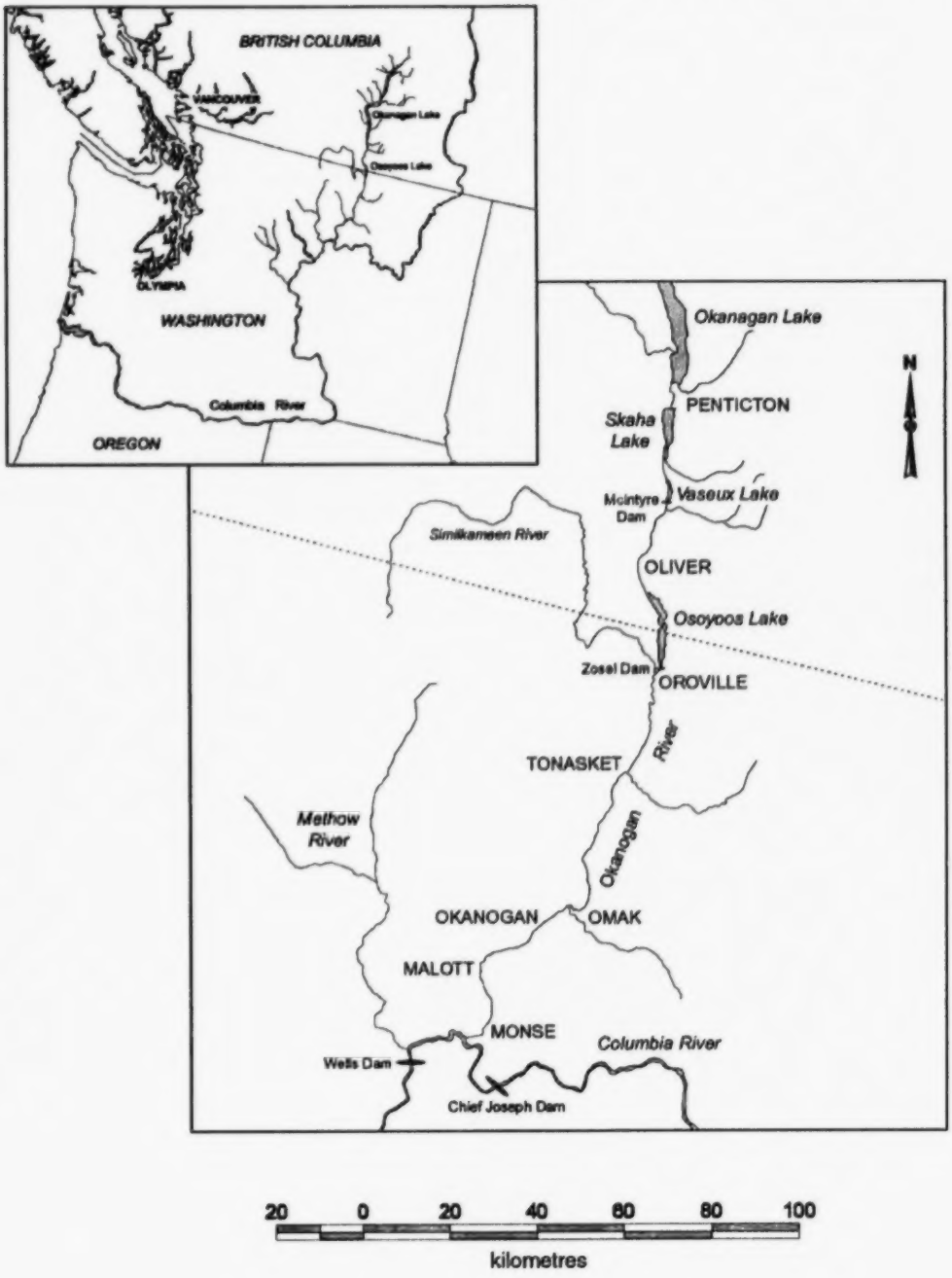


Figure 2. Location of the Okanagan River and Osoyoos Lake study area.

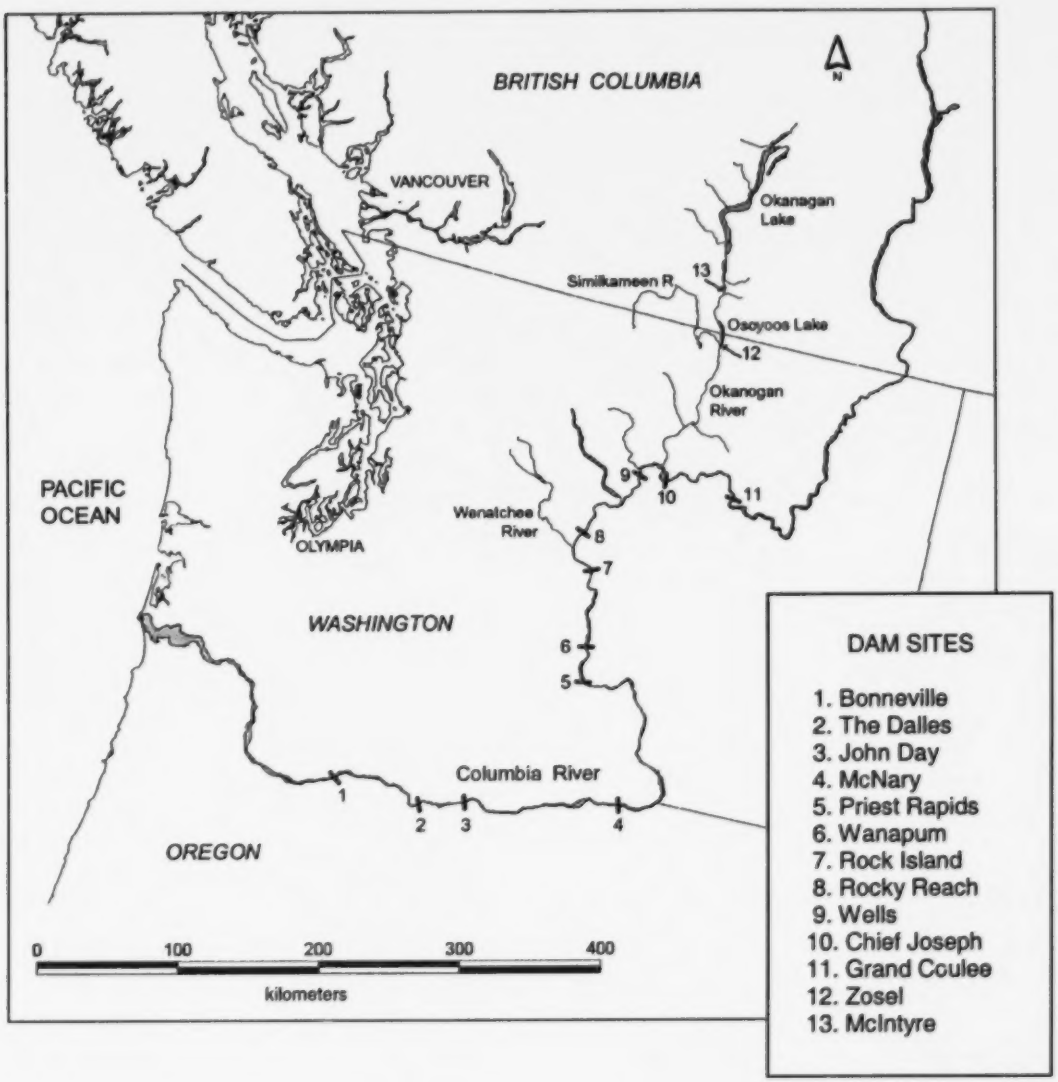


Figure 3. Locations of dam sites along the sockeye salmon migration route through the Columbia and Okanagan rivers.

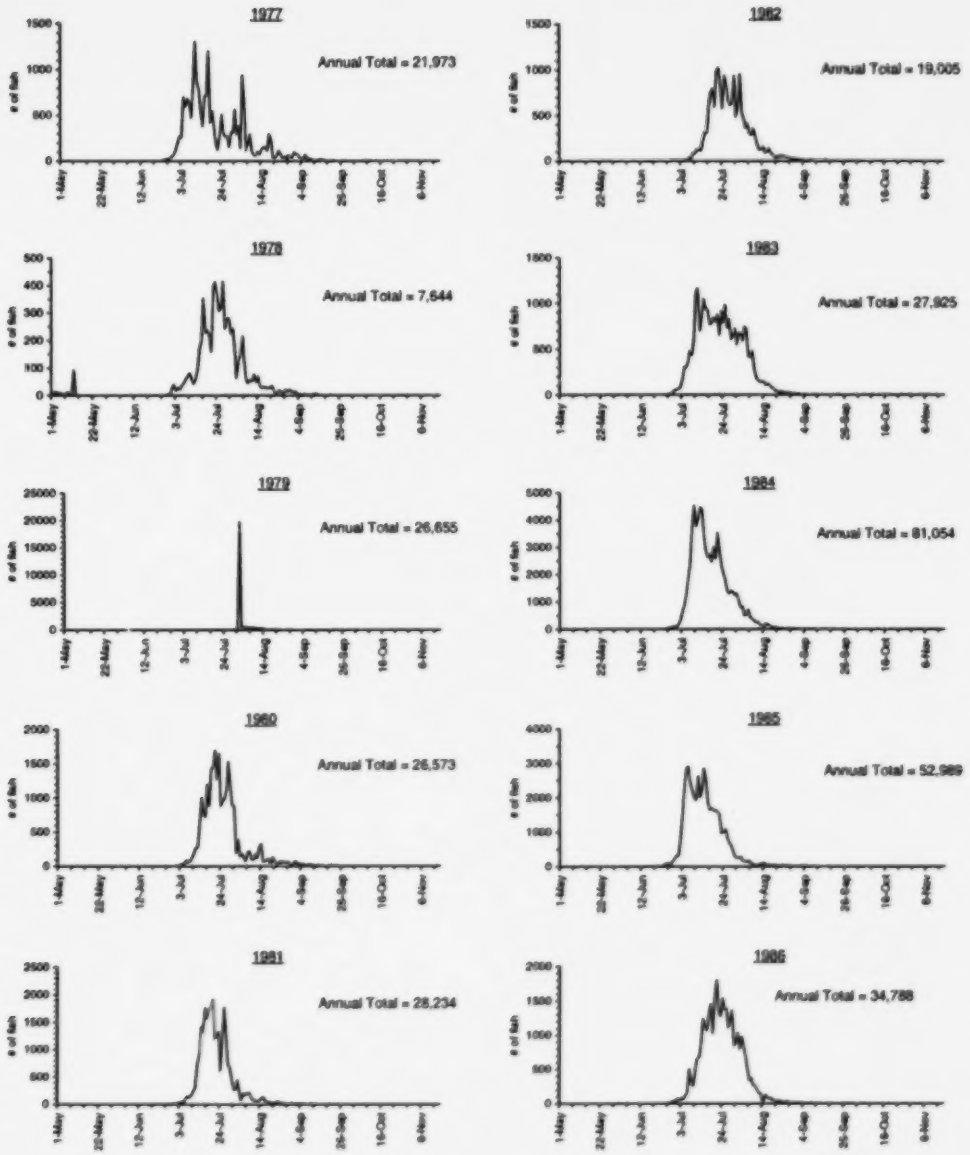


Figure 4. Daily passage of adult sockeye migrating through Wells Dam for the years 1977 to 2001.

Passage in 1997 appears to be anomalous as the pattern suggests that 75% of the fish passed Wells Dam on 1 day (August 1). Daily counts for sockeye passage at Wells Dam were obtained from the University of Washington, Columbia River DART web site at <http://www.cbr.washington.edu/dart/adult_rpt.html>.

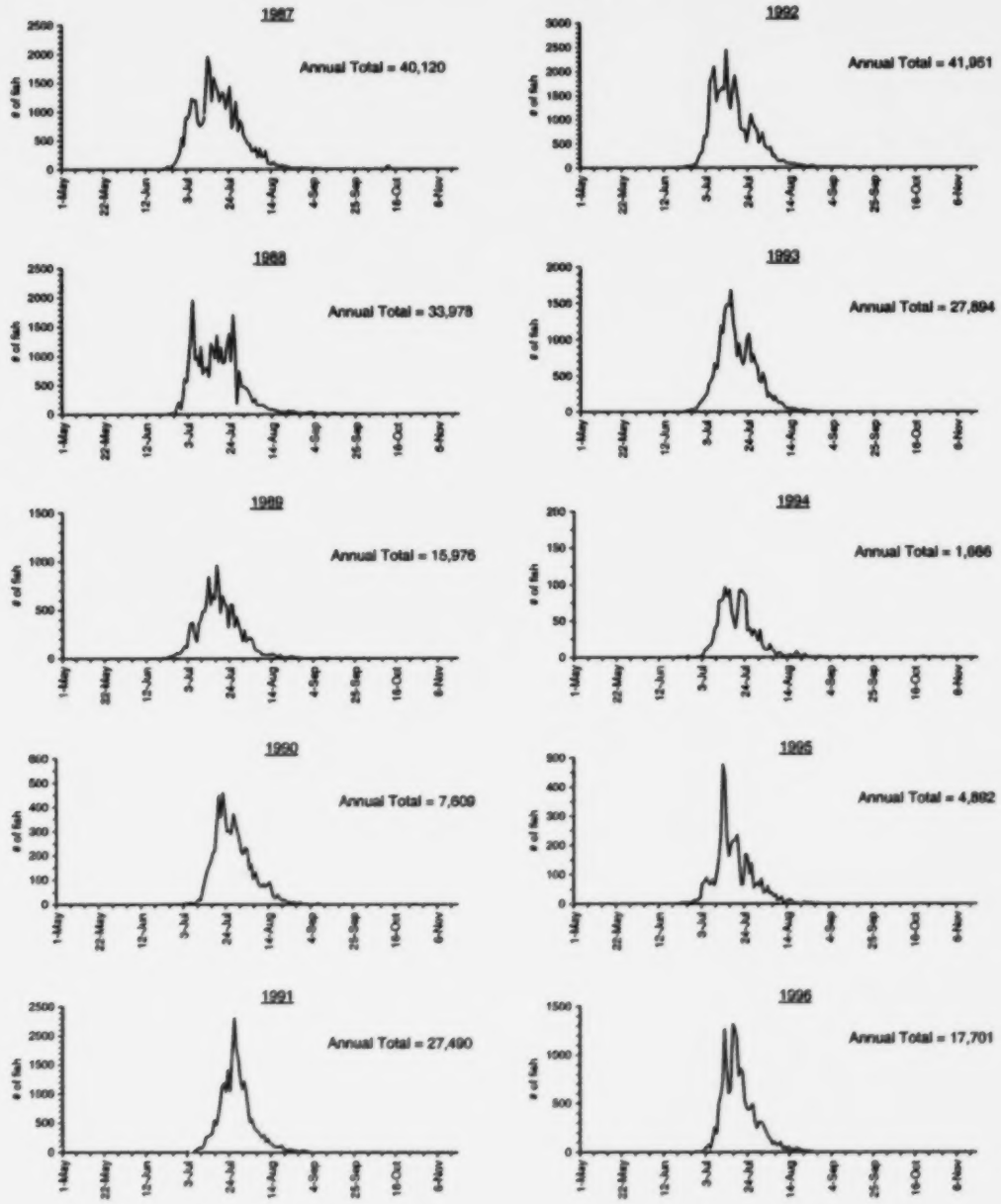


Figure 4 (cont'd)

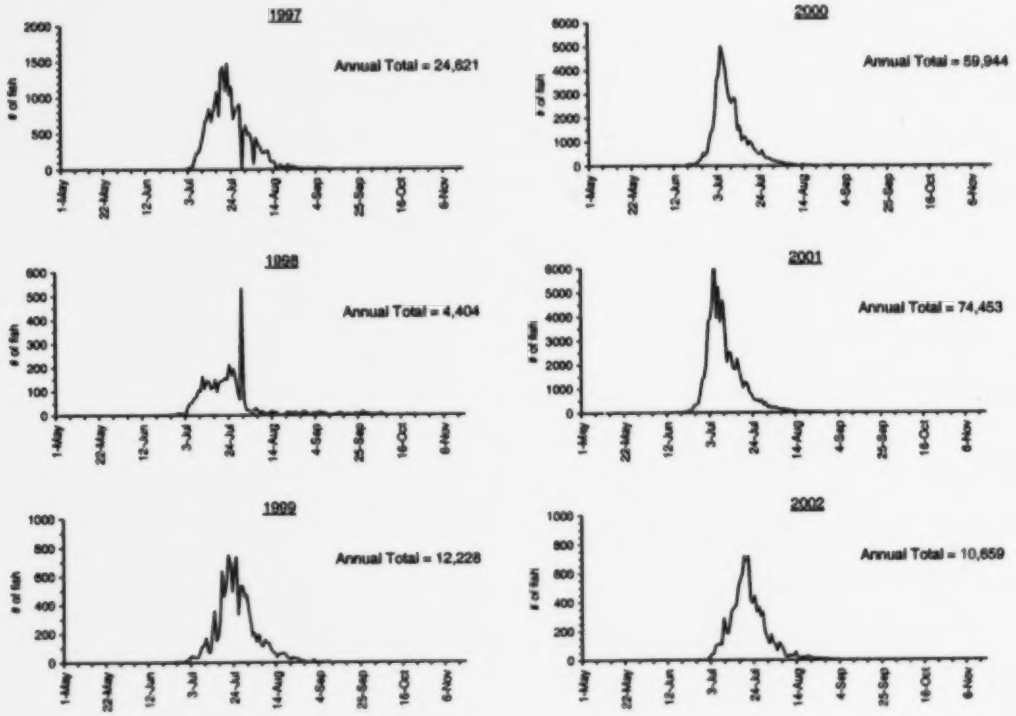


Figure 4 (cont'd)

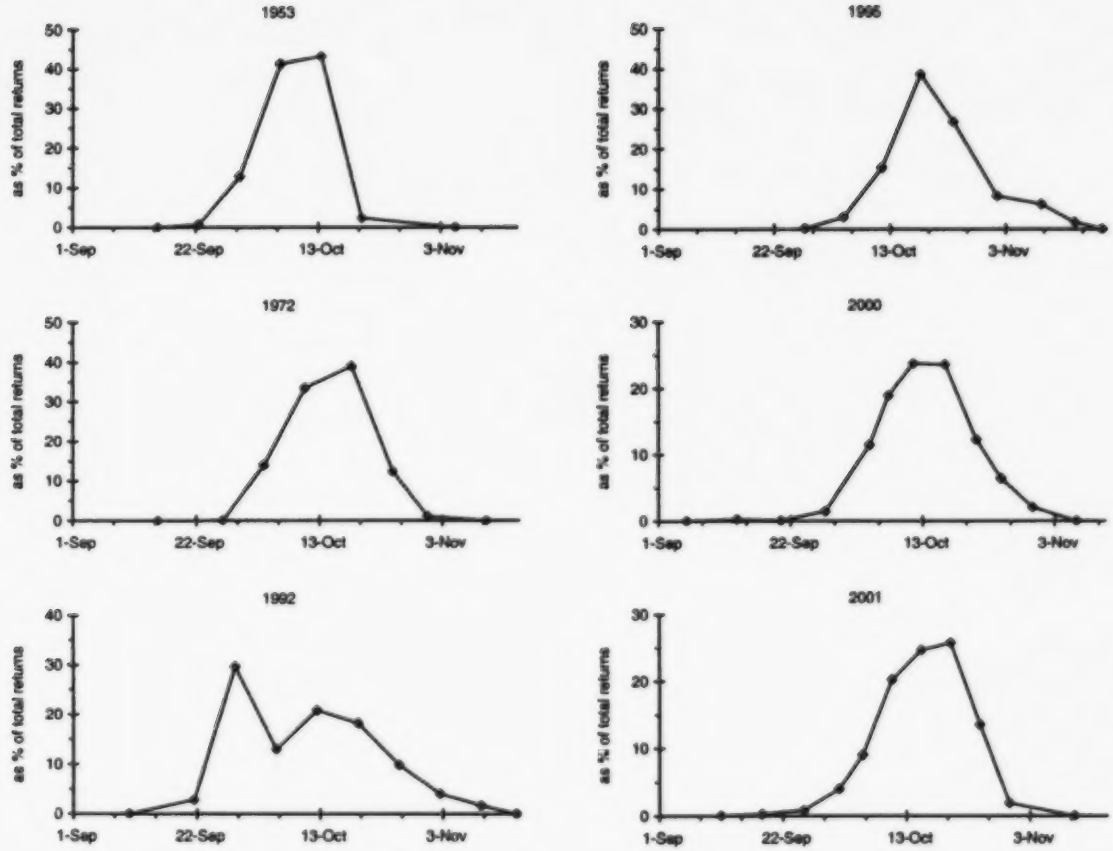


Figure 5. Sockeye spawn timing distributions (as % total sockeye observed) in the Okanagan River for the years 1953, 1972, 1992, 1995, 2000 and 2001.

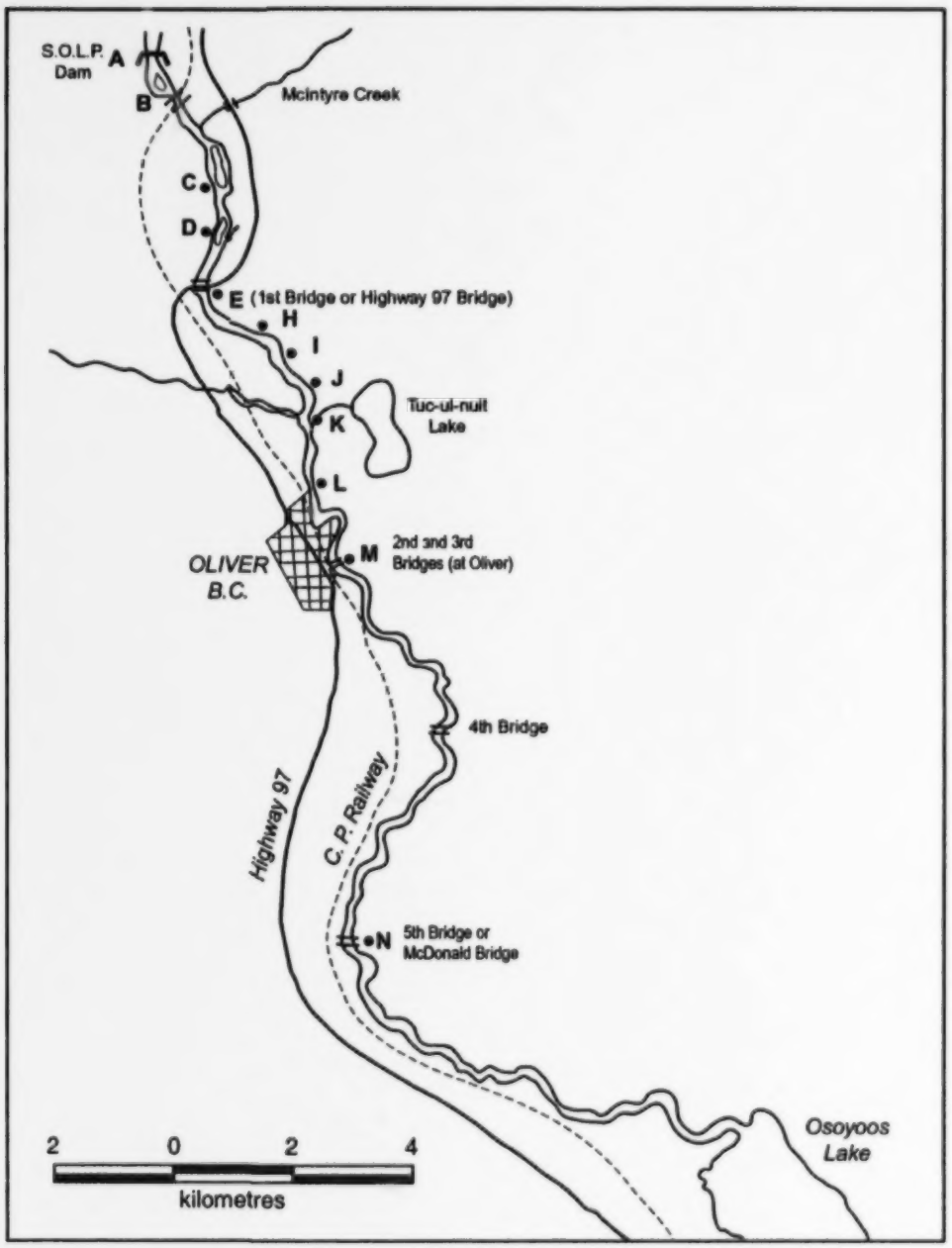
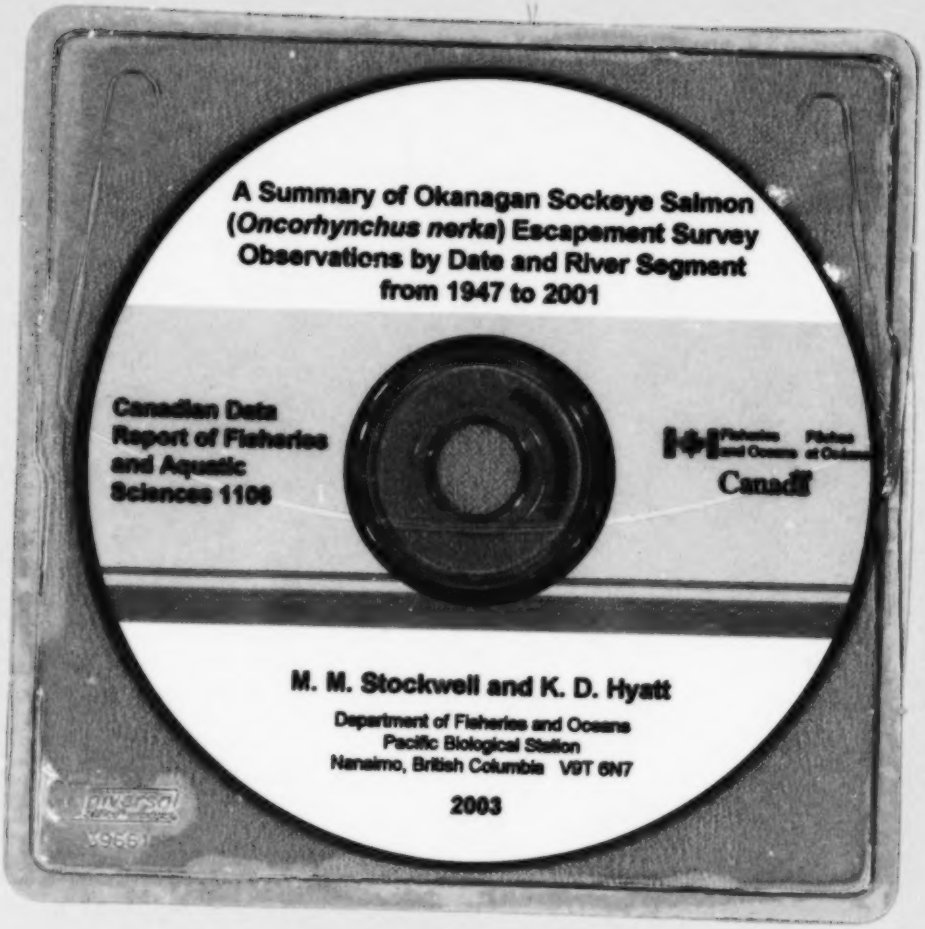


Figure 6. Okanagan River sockeye spawning grounds and enumeration markers prior to construction of flood control structures in 1954. Map adapted from figures in Gangmark and Fulton 1952 (Figure 8), Anon. 1954 (Figure 13) and Craddock 1958 (Figure 1).

Figure 7. Okanagan River sockeye spawning grounds between Vaseux and Osoyoos Lakes after construction of flood control structures, including locations of vertical drop structures 1 to 13.


A Summary of Okanagan Sockeye Salmon (Oncorhynchus nerka) Escapement Survey Observations by Date and River Segment from 1947 to 2001
Canadian Data Report of Fisheries and Aquatic Sciences 1108
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M. M. Stockwell and K. D. Hyatt
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